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Though it can be shown that the 962 cases of chorea originated from 6 or 7 ancestors and that the tendency has been handed down almost without a break through the generations and that for generations there have been individuals who recognized the hereditary nature of the disease and were influenced in marriage accordingly; nevertheless, there is no clear evidence that persons belonging to the choreic lines voluntarily abstain to any marked degree from, or are selected against, in marriage.

THE ALCYONARIA AS A FACTOR IN REEF LIMESTONE FORMATION

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The early students of coral reef formation based their conclusions concerning the depth at which reef formation could take place and the rate at which material was added to such reefs upon the known bathymetrical distribution and growth rate of stony corals (Madreporaria). The results obtained from the examination of the cores from borings made at the Island of Funafuti in the South Pacific showed that, in this particular region at least, calcareous algae of the genus *Halimeda* were a very important factor in reef limestone formation. Among the other group of lime secreting animals, those species of Alcyonaria, which form a massive skeleton have received proper recognition as contributing to reef formation. The remaining representatives of this group have been neglected as reef formers because their limy secretion is laid down in the form of minute spicules which are set free at the time of the disintegration of the living tissues of the colony leaving no recognizable skeleton.

On most coral reefs in all parts of the world the Alcyonaria with free spicules are much more abundant than those forming a massive skeleton while in many regions they constitute by far the greatest part of all lime secreting organisms living permanently attached to the bottom. On many reef areas in the Florida-Antillean region the areas occupied by stony corals and calcareous algae are relatively small while flexible alcyonaria or the family Gorgonaceae make up the most characteristic feature of the fauna. The spicules of these organisms are found in practically all bottom samples both from the crests of the reefs and in the soft mud from the channels between the reefs so it is evident that they may be incorporated into the reef limestones before they have undergone marked erosion.

In order to determine the amount of material contributed to reef formation, during any given time, by the gorgonians, three factors must be taken into consideration: first, the amount of lime held as spicules in the tissues of these colonies; second, the bulk of the gorgonians present on any reef area; and third, the number of colonies which will set free their spicules through the death and subsequent disintegration of their coenenchyma.

1. *Spicule content.* In making the determination of the amount of spicules for any species the colony was removed from the reef without injury to any portion except the expanded base, which was always discarded as it was difficult to separate from it fragments of limestone from other sources. The colony was then weighed while still wet, cut into small pieces and the living tissue destroyed by treatment with a cold 25% solution of caustic soda. When the organic material had been dissolved the spicules were washed in rain water until no trace of organic matter remained, collected on a weighed filter, dried in a water bath kept at 100°C. and after cooling in a dessicator to room temperature, carefully weighed. By this procedure the proportion of spicules to the fresh weight of the colony could be estimated for any collection of gorgonians by simply separating the several species and determining the weight of each one.

As previous studies upon the growth rate and ecology of the gorgonians of this region had shown that at least nine-tenths of the bulk of these organisms on any reef is made up of not more than twelve species, the spicule determinations were consequently restricted to these forms. The results of analyses of the twelve most common species is shown in the table in which the figures given represent the average of five determinations for each species.

AVERAGE WEIGHT IN POUNDS AND PERCENTAGE OF SPICULES IN GORGONIAN COLONIES

<i>Species of gorgonian</i>	<i>Average weight of colonies</i>	<i>Percent spicules</i>	<i>Species of gorgonian</i>	<i>Average weight of colonies</i>	<i>Percent spicules</i>
Briareum sp.....	2.00	26.66	Plexaurella dichotoma....	0.75	35.86
Eunecia rousseaui.....	1.00	35.60	Plexaurella sp.....	0.75	24.92
Eunecia crassa.....	0.30	22.66	Gorgonia flabellum.....	1.00	22.33
Plexaura flexuosa.....	1.00	30.66	Gorgonia acerosa.....	3.00	19.75
Plexaura homomalla.....	1.50	27.41	Gorgonia citrina.....	0.25	35.05
Pseudoplexaura crassa.....	2.50	21.48	Xiphigorgia anceps.....	0.25	25.83
Average proportion of spicules for all species			27.40%		

The determinations given above were made primarily to afford a basis from which the spicule content of large masses of gorgonians could be calculated and in order to have a check for these computations a series

of twenty analyses were made of the gorgonians growing upon a square yard of the surface of widely separated reefs. The bulk of the gorgonians varied from 1.5 pounds to 25.0 pounds, the spicule content from 0.45 pounds to 6.94 pounds, for the different squares. The average for all determinations was 7.746 pounds of gorgonian colonies containing 2.1225 pounds of spicules.

2. *Distribution of gorgonians on the reefs about Tortugas.* To determine the distribution of the species of gorgonians included in the foregoing analyses on the reefs about Tortugas a series of lines were laid out extending over a number of the most important reefs and along these lines counts of the number of gorgonians occurring on a square yard were made at regular intervals, with the following results:

	Squares	Average number of colonies	Number barren squares
Line No. 1.....	45	5.72	8
Line No. 2.....	150	8.97	14
Line No. 3.....	30	10.86	3
Line No. 4.....	25	7.62	1
Line No. 5.....	40	13.27	7
Line No. 6.....	36	5.86	5

In these counts the number of colonies was alone recorded for each square yard. The weight of the mass of gorgonians on any square was estimated upon the basis of the determinations shown in the second column of the first table in which the figures represent the average weight for twenty medium sized colonies of each species.

Computed upon this basis the average weight of the gorgonians from each square along line No. 1, as given above, is 7.32 pounds. Estimating the spicule contents on the basis of the figures obtained from the analyses recorded in the table it is shown that there would be two pounds of spicules in the gorgonians from any square yard of reef area along this line. This result approaches very closely the amount found by actual analyses of the colonies from twenty representative squares. The number of colonies to the square along this line was the smallest found in the counts on any of the reefs so that when estimated upon the same basis the spicule content of the gorgonians on the squares along the lines on any of the other reefs would be greater than that found by actual analyses for the twenty squares previously mentioned. Using the smaller figure, which is well below that obtained by careful observation, the amount of lime held as spicules in the tissues of living gorgonians on a representative acre of reef area is 5.28 tons.

3. *Disintegration of the gorgonian colonies and the addition of their spicules to the reef building materials.* The spicules held in the tissues

of Gorgonian colonies represent only a potential contribution to reef formation. The actual number of gorgonians destroyed on any reef area in a given year can not be determined save by actual observation extending over the entire period, a method that had been impossible to carry out. A considerable number of observations bearing directly upon this phase of the subject has, however, been accumulated in the course of ecological studies on the gorgonians of the Tortugas regions, extending over a period of five years.

These observations have shown that when a gorgonian colony is removed from its place of attachment on the reef and allowed to lie on the bottom where it will be moved by the action of tidal currents death follows within a short time. The amount of time necessary for the complete disintegration of the coenenchyma of a colony of each of the several species which make up the most important elements in the gorgonian fauna about Tortugas was determined. This series of observations showed that when torn from the bottom, the most resistant form—*Gorgonia flabellum*—would be disintegrated within 120 hours, while a colony of *Pseudoplexaura crassa* would be broken down in 18 hours. Under normal conditions of the reefs the greatest number of the axial skeletons of dead colonies are found in positions which indicate that the tearing of the colony from its normal attachment by wave action is the cause of the greatest mortality among these animals. When destroyed in this manner the spicules of any gorgonians would be added to the limestone forming materials on the reef within a few days, at most, from the time when the colony was torn from its place of attachment and consequently before the spicules had undergone any noticeable erosion.

Next to the destruction by wave action (storms) the greatest mortality of the gorgonians is brought about by the overgrowth of their tissues by other organisms. The most important of these agents are the hydrocoralline *Millipora alcicornis* and some encrusting bryozoa. Under the influence of both these agents the tissues of the gorgonian are disintegrated very slowly and the spicules set free a few at a time. While the *Millipora* will eventually cause the complete destruction of a colony the bryozoa were never found to extend for more than a few inches above the base of the colony. The actions of the two sorts of organisms is markedly different in that the *Millipora* causes the death of the gorgonian tissues by some chemical action and itself encrusts only the axial skeleton of the colony; while the bryozoa form a cylindrical tube surrounding the base of the gorgonian and cause the death of its tissues by the exclusion of food and oxygen.

There is no evidence that gorgonian colonies ever die from old age and to the agencies mentioned above is to be attributed the destruction of all those colonies the skeletons of which are found on the reefs. The fascies of the gorgonian fauna on any reef remains practically unchanged from year to year except for the introduction of the unusual factor of extensive destruction of the colonies by severe storms. The determination of the number of skeletons of dead colonies on any reef area will, therefore, afford the most practicable method of obtaining the death-rate of these organisms. This method unfortunately has the serious drawback that the results will always be too low because when the colonies are torn from their attachment on the reef by severe storms some of them will be carried so far from their original location that they will not be included in a count of skeletons on any given area. The percentage of axial skeletons to living colonies on a small reef where the entire number of colonies has been counted each year since 1910 has varied from 11.67% to 24.80% with an average of 17.22% for the six counts. On other reefs in the Tortugas region the destruction of gorgonians was nearly complete in the hurricane of October 17, 1910. In some restricted areas the amount of spicules set free from disintegrating gorgonian colonies was as much as 25 pounds to the square yard. On the basis of all the recorded observations it seems probable that, at a conservative estimate, about one-fifth of the gorgonian colonies on any reef area will be destroyed annually.

Since the fascies of the gorgonian fauna on the reefs remains relatively constant, and it is estimated that about one-fifth of the number of colonies are destroyed annually, it is important to determine the growth rate of the several species of these organisms which make up the most important elements in the gorgonian fauna.

Growth records for the species entering into this study have been kept for a period sufficiently long to cover the period from the time of their attachment as planulae to the attainment of the normal average size of the colony. The time necessary for this growth varies from two years (*Gorgonia citrina*), to five years (*Gorgonia acerosa*). The time necessary for any of these colonies to reach the average size falls well within the limit marked by the observed rate of destruction which would be necessary to maintain the constancy of the gorgonian fauna of any reef. Some few of these species appear to keep growing for an indefinite period after the medium size for the colony has been reached, but in such instances the growth is very slow after this time and would not greatly influence the general results.